Ventral fins apparently 9-rayed. A dark spot on the back, extending on to the base of the anterior branched rays of the dorsal fin. In other respects apparently very similar to *V. hypselopterus*.

*Hab.* North-west coast of Australia.

A single rather badly preserved specimen, 55 mm. in total length.

## 5. On the Anatomy, Classification, and Systematic Position of the Teleostean Fishes of the Suborder *Allotriognathi*. By C. Tate Regan, M.A., F.Z.S.

[Received May 21, 1907.]

(Text-figures 166–171.)

### 1. *Descriptions of Skeletons.*

The fishes of the families Lamprididæ, Veliferidæ, Trachypteridæ, and Lophotidæ have not usually been placed together by systematists, but it is the object of the present communication to show that they form a natural group and may be regarded as comprising a suborder of the order Teleostei. The reasons for this will be apparent when the skeletal anatomy of the various types has been described.

#### *Lamprididæ.*

This family comprises a single species, *Lampris luna*, of which I have examined a skeleton. This is not in very good condition, and I am indebted to Messrs. W. and I. Sherrin for the opportunity of ascertaining the exact limits of the supraoccipital and orbitosphenoid bones in a fresh specimen.

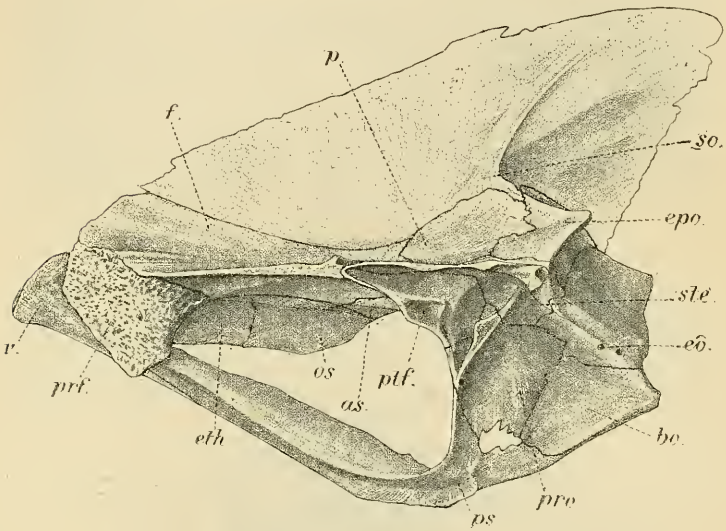
The cranium (text-fig. 161) does not differ very essentially from that of the Berycoid fishes which have been described and figured by Starks*, although the great development of the occipital crest, which extends to the anterior extremity of the frontals, gives it a different appearance. The parietals and epiotics are separated by the supraoccipital, the exoccipitals bound the *foramen magnum*, and the basisphenoid and orbitosphenoid are present. Cranial features of importance are the absence of an opisthotic (present and well-developed in all Berycoids), the extension forward of the supratemporal (pterotic) to the frontal, so that the postfrontal (sphenotic) does not appear on the upper surface, the position of the mesethmoid, the anterior part of which is embraced by the præfrontals but which extends backwards and meets the orbitosphenoid, and the structure of the vomer, which has a pair of grooves separated by a median longitudinal keel on its anterosuperior surface.

The maxillary has an inner posterior process which underlies the similar process of the præmaxillary and slides backwards and

* Proc. U.S. Nat. Mus. xxvii. 1904, pp. 601–619.

forwards in the groove at the side of the vomerine keel. This is quite a different arrangement to that usually found in fishes with protractile mouths. In the Berycoids the maxillary is articulated proximally to the vomer and has a ligamentous attachment to an anterior process of the palatine, so that only the distal end moves forward when the præmaxillaries are protruded. In *Lampris*, however, it is the maxillaries which are protractile and which carry the præmaxillaries forward.

Text-fig. 166.




Cranium of *Lampris luna*.

*v.*, vomer; *f.*, frontal; *p.*, parietal; *so.*, supraoccipital; *epo.*, epiotic; *ste.*, supratemporal (pterotic); *eo.*, exoccipital; *bo.*, basioccipital; *ps.*, parasphenoid; *pro.*, prootic; *ptf.*, postfrontal (sphenotic); *as.*, alisphenoid; *os.*, orbitosphenoid; *eth.*, ethmoid; *prf.*, prefrontal.

There is no supramaxillary bone. Except for the absence of a maxillary process of the palatine, the bones of the hyo-palatine and opercular series exhibit no departure from the normal type. The suborbitals do not form a subocular shelf. The branchiostegal rays are six in number.

There are 46 vertebræ, 21 præcaudals and 25 caudals. The centra are solid and co-ossified with the arches. The first centrum is convex anteriorly, fitting the concavity formed by the basi- and ex-occipitals. There are no parapophyses and the long ribs are sessile. The pectoral arch has been figured by Boulenger*; the forked post-temporal is attached to the epiotic above and to the exoccipital below; the coracoids are greatly expanded; the rays of

* Ann. Mag. Nat. Hist. (7) x. 1902, pp. 147–152, fig.

the pectoral fin are attached to the scapula and to three pterygials, two of which are inserted on the scapula and one on the coracoid; the post-clavicle is long and slender and consists of a single piece.

The pelvis comprises a pair of erect subtriangular bony plates which are attached to the coracoids, each having a groove on the anterior part of its outer surface for the reception of the posterior edge of the coracoid.

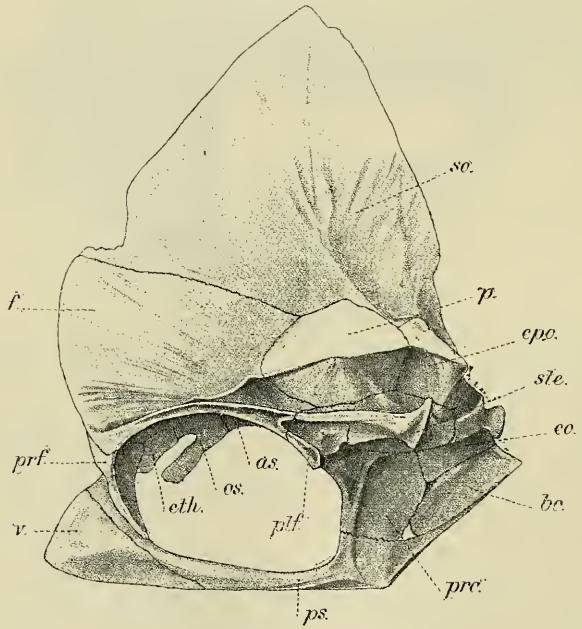
*Veliferidæ.*

I have prepared the skeleton of an example of *Velifer hypselopterus*.

As will be seen from the accompanying figures (text-figs. 166, 167) the cranium bears a striking resemblance to that of *Lampris* in general form, and it comprises the same bones which have very nearly the same relation to each other. The important differences are the following:—

There is a considerable amount of cartilage in the orbital and ethmoidal regions, and there is a large anterior cavity the floor of

Text-fig. 167.




Cranium of *Velifer hypselopterus*.
Lettering as in text-fig. 166.

which is formed by cartilage and by the orbitosphenoid, mesethmoid, and præfrontal bones, and the sides and roof by the præfrontals and frontals.

The mesethmoid is entirely posterior to the præfrontals. In front of the mesethmoid the cartilaginous floor of the anterior cranial chamber bears a median keel, corresponding to the keel of the vomer in *Lampris*. In *Velifer*, however, the vomer does not ossify through, but only sends up a pair of wings which flank the præethmoid cartilage.

The mouth (text-fig. 170, p. 640) is more protractile than in *Lampris*, but the præmaxillaries and maxillaries are arranged on the same plan. The hyo-palatine, orbital, and opercular bones are as in *Lampris*.

The vertebral column comprises 33 vertebræ, 16 præcaudals and 17 caudals; the ribs are attached to downwardly directed parapophyses; the first centrum is short and is convex anteriorly.

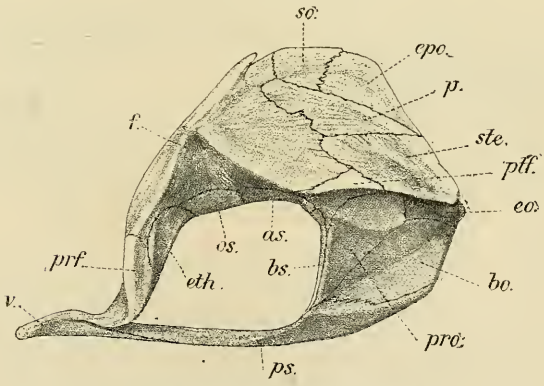
The pectoral arch differs from that of *Lampris* in that the coracoid is normal and the pterygials are 4 in number, the last in contact with the coracoid. As in *Lampris* the post-clavicle is simple and elongate.

The pelvic bones are a pair of erect subtriangular plates, with their apices imbedded in the ligamentous tissue between the coracoids.

*Trachypteridæ.*

The skeleton of *Trachypterus tænia* is feebly ossified, and the bones are very thin and light, almost papery. There is no occipital crest, and the epiotics meet behind the supraoccipital, but in all other essentials the cranium (text-fig. 168) agrees with that of *Velifer*.

Text-fig. 168.




Cranium of *Trachypterus tænia*.

Lettering as in text-fig. 166. *bs.*, basisphenoid.

Of the orbital bones only the præorbital is ossified. The maxillary and præmaxillary (text-fig. 169, p. 639) are on the same plan as in *Velifer*, but the former bone has the outer blade expanded and closely attached to the præmaxillary

The vertebral column comprises 90 vertebræ; the præcaudals have downwardly directed parapophyses; ribs appear to be absent. The pectoral arch differs from that of *Velifer* in that the post-temporal is simple and that the pectoral pterygials are 3 in number, two of which are inserted on the coracoid.

The pelvic bones resemble those of *Velifer* in structure and attachment, but have the posterior angle produced and embraced by the extremities of the post-clavicles.

The skeleton of *Regalecus* has been described by Parker * and Dunbar †. I have examined the large skeleton described by Parker, which is essentially similar to that of *Trachypterus*, differing in the absence of a basisphenoid and in the presence of some feeble ribs.

The post-frontal and pro-otic bones in *Regalecus* are situated as shown in the accompanying figure of *Trachypterus* (text-fig. 168, p. 637).

The descriptions of both Parker and Dunbar, who have determined the greater part of the pro-otic bone as opisthotic, are erroneous.

The pelvic bones in *Regalecus* are considerably larger than in *Trachypterus* and their anterior edges lie between the clavicles.

### *Lophotidæ*.

I have examined a spirit specimen of *Lophotes cepedianus*. The moderately protractile mouth is similar in structure to that of *Trachypterus*; by depressing the large eye of one side I have been able to ascertain that an orbitosphenoid bone is present and that it is in contact with the mesethmoid, which is entirely posterior to the præfrontals; dissection of the base of the pectoral fin on one side shows that the relations of scapula, coracoid, and pterygials are as in *Trachypterus*.

For *Lophotes fiskii* Gthr. I propose the new generic name *Eumecichthys* ‡. The mouth is non-protractile, the posterior processes of the præmaxillaries having their extremities attached to the anterior face of the vomer, instead of sliding backwards and forwards on each side of a median longitudinal keel, as in *Lophotes*.

2. *Definition and Classification of the Suborder* Allotriognathi.

Suborder Allotriognathi.

Supraoccipital well-developed, separating the parietals; no opisthotic; an orbitosphenoid, anteriorly in contact with the mesethmoid, which is wholly or in part posterior to the præfrontals. Mouth typically protractile; maxillary with an outer

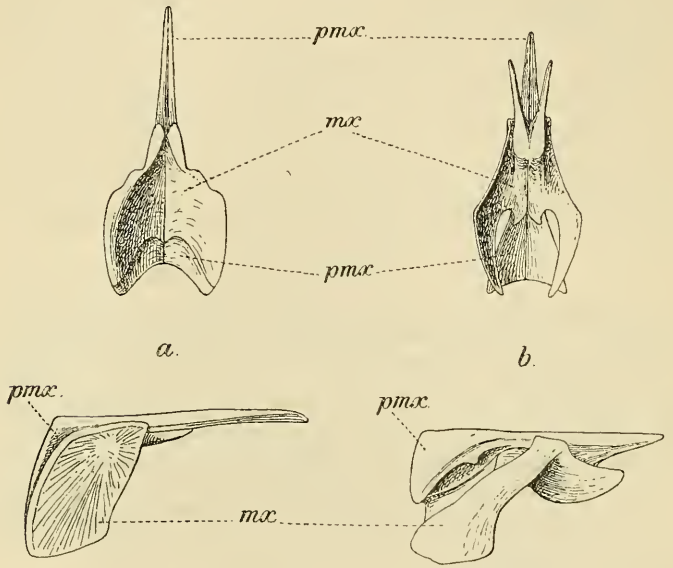
* Trans. Zool. Soc. xii. 1886, pp. 5–33, pls. ii.–vi.

† Proc. Zool. Soc. 1906, pp. 547–566, pls. xxxviii. & xxxix.

‡ Boulenger (Mar. Inv. S. Afr. i. 1902, p. 13) writes: "*Lophotes fiskii* differs very widely from the tropical form of the genus; its extremely elongate, ribbon-like form and the probable absence of an anal fin, to say nothing of the frontal crest and the absence of ventral fins, indicates, in my opinion, a distinct genus."

blade and with an inner posterior process which is connected with its fellow below the præmaxillary spines; maxillary processes typically sliding backwards and forwards on each side of a median keel on the vomer or on the præethmoid cartilage *; no supramaxillary; lower jaw composed of dentary, articulare and angulare. Palatine without an anterior process for attachment of the maxillary. Vertebral column of solid centra which are co-ossified with the arches. Gills pectinate. Pectoral arch attached to the cranium; no mesocoracoid; post-clavicle elongate, of a single piece. Air-bladder without pneumatic duct. Vertical fins without true

Text-fig. 169.




Præmaxillaries (*pmx.*) and maxillaries (*mx.*) of *Trachypterus tænia* (*a.*) and *Velifer hypselopterus* (*b.*), seen from below and from the side.

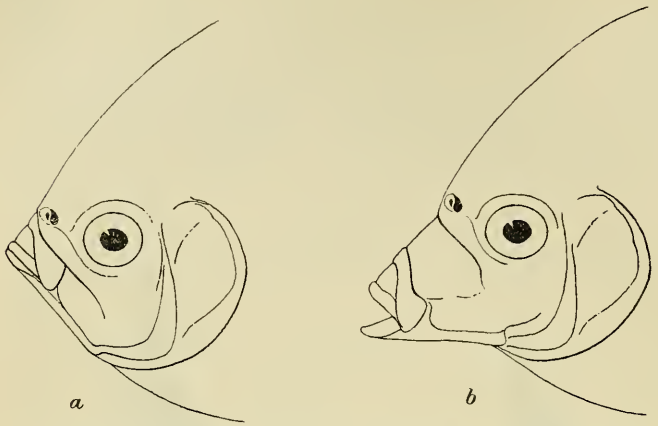
spines (except sometimes the first one or two rays of the dorsal); pectoral fin with horizontal or sub-horizontal base; ventral fins, if present, below or a little behind the pectorals, without spines; pelvis comprising a pair of erect subtriangular bony plates, inserted in the ligament between the coracoids and sometimes directly articulated with them.

In addition to the characters given in the diagnosis we may note that all the Allotriognathi have the head without spines or serrations, 6 branchiostegals, 4 gills, and well-developed pseudo-

* In the most specialised member of the group, the Lophotid *Eumecichthys*, the mouth is not protractile, and the posterior ends of the præmaxillary processes are attached to the anterior face of the vomer.

branchiæ. Teeth are usually feeble or absent, never strong, and the scales, if present, are thin and deciduous or reduced to scattered tubercles.

Text-fig. 170.




Head of *Velifer hypselopterus* with the mouth closed (*a*) and protruded (*b*).

### Division 1. **Selenichthyes** (Boulenger).

Body deep, compressed; skeleton well-ossified; cranium without cartilage. No anterior cranial chamber; frontals normal, in contact below with the mesethmoid and orbitosphenoid; mesethmoid partly between and partly posterior to the præfrontals; epiotics separated by the supraoccipital. Vertebræ in moderate number (46); no parapophyses; ribs strong, sessile. Post-temporal forked; pectoral fin-rays inserted on the scapula and on 3 pterygials, one of which is in contact with the coracoid; pelvic bones articulated to the greatly expanded coracoids. Fins without spines, composed entirely of articulated rays; dorsal and anal fins long; ventral fins of 15 to 17 rays.

Family Lamprididæ. A single genus, *Lampris* Retzius.

### Division 2. **Histichthyes.**

Body deep, strongly compressed; skeleton well-ossified, but the cranium with a considerable amount of cartilage. A large anterior cranial chamber, the walls of which are mainly formed by the frontals, the floor by cartilage containing the mesethmoid and orbitosphenoid ossifications; mesethmoid entirely posterior to the præfrontals; epiotics separated by the supraoccipital. Vertebræ in moderate number (33); ribs strong, attached to well-developed downwardly directed parapophyses. Post-temporal forked; pectoral fin-rays inserted on the scapula and on 4 pterygials, one of which is in contact with the coracoid, which is not expanded; pelvic

bones not articulated to the coracoids. Fins composed of articulated rays, except the first two rays of the dorsal, which are spinous; dorsal and anal fins long; ventral fins of 8 or 9 rays.

Family Veliferidæ. A single genus, *Velifer* Schleg.

### Division 3. **Tæniosomi** (Gill).

Body elongate, strongly compressed; skeleton feebly ossified, the bones thin; cranium with a considerable amount of cartilage. An anterior cranial chamber or groove, the walls of which are mainly formed by the frontals, the floor by cartilage containing the mesethmoid and orbitosphenoid ossifications; mesethmoid entirely posterior to the præfrontals; epiotics meeting behind the supraoccipital. Vertebræ numerous (90 to 93); præcaudals with downwardly directed parapophyses; ribs feeble or absent, if present attached to the parapophyses. Post-temporal simple; pectoral fin-rays inserted on the scapula and on 3 pterygials, two or all of which are in contact with the coracoid; pelvic bones not articulated to the coracoid, but inserted in the ligamentous tissue between them. Fins composed of flexible, non-articulated rays (the first ray of the dorsal sometimes spinous); dorsal fin very long; anal short or absent; ventral fins, if present, of 1 to 9 rays.

Family 1. Trachypteridæ.

Ventral fins present, close together, of 1 to 9 rays; no anal fin; vent about in the middle of the length of the fish.

Two genera, *Trachypterus* Gouan, and *Regalecus* Brünn.

Family 2. Lophotidæ.

Ventral fins, if present, small, of 5 or 6 rays, widely separated, inserted a little below and behind the pectorals; a short anal fin; vent posterior, just in front of the anal.

Two genera, *Lophotes* Giorna, and *Eumecichthys* Regan.

### 3. *Systematic Position of the* Allotriognathi.

The Allotriognathi and the Beryciformes are the only fishes which combine the presence of an orbitosphenoid with the absence of a mesocoracoid. The two groups agree also in having the ventral fins placed more or less anteriorly and often composed of a large number of rays (up to 17 in the Allotriognathi, up to 14 in the Beryciformes), and in being physoclistic (with the exception of *Beryx* and *Holocentrum*).

In cranial structure the Beryciformes differ from *Lampris* (which has the most generalised cranium of the Allotriognathi) only in being less specialised; *i. e.*, the opisthotic is well-developed, the maxillary carries 1 or 2 supramaxillaries, is normally articulated to the vomer and is attached to a process of the palatine. The pectoral arch of *Velifer* is identical with that of the Beryciformes.

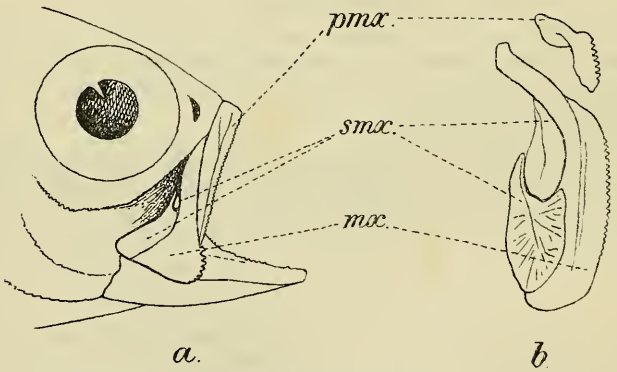
Taking the Beryciformes in the most restricted sense, they

include fishes without spines in the ventral fins and with the pelvic bones free from the pectoral arch (i. e., *Polymixia*), but all the living members of the group (if we omit *Stephanoberyx*, of which the anatomy is unknown) have the dorsal and anal fins preceded by spines. Except for this they are exactly fitted for giving rise to the Allotriognathi, and there can be little doubt that the latter had a Berycoid origin.

The origin of the Berycoid fishes themselves is another question. Smith Woodward and Boulenger place them at the base of the Acanthopterygian series, and adduce the persistence of the pneumatic duct (in *Holocentrum* and *Beryx*), the large number of rays in the ventral fins, and the abundance of the group in Cretaceous times as evidence of their generalisation. More recently Starks has shown that an orbitosphenoid bone is present in most Malacopterygii, all Ostariophysi and the Beryciformes, but not in the Haplomi or other higher groups.

I find that in most species of *Myripristis* (text-fig. 171 *a*) the maxillary is toothed and enters the gape when the mouth is widely opened, and that in the Polymixiidæ, Berycidæ, and Holocentridæ there are two supramaxillaries, which evidently correspond to those of the Clupeoid Fishes.

Text-fig. 171.




*a*. Anterior part of head of *Myripristis murdjan*.
*b*. Upper jaw of *Ctenothrissa radians* (after Smith Woodward)..
*pmx*., præmaxillary; *mx*., maxillary; *smx*., supramaxillaries.

All these facts taken together lead me to believe that the Beryciformes may have evolved directly from Malacopterygii such as the Cretaceous *Ctenothrissa* (text-fig. 171 *b*) and *Pseudoberyx*, to which they bear a considerable resemblance.

A number of fishes have at times been associated with one or other of the families of Allotriognathi, and some of these must be discussed.